



Superfund Research Program

The Superfund Research Program (SRP) supports practical research that creates benefits, such as lower environmental cleanup costs and reduced risk of exposure to hazardous substances, to improve human health. SRP funds colleges, universities, and small businesses, including the Northeastern University Puerto Rico Testsite for Exploring Contamination Threats (PROTECT) Superfund Research Center (SRC), to advance this work across the nation. PROTECT is a multi-project, multi-institution collaboration that involves Northeastern University, University of Puerto Rico Medical Sciences Campus, University of Puerto Rico at Mayaguez, and University of Michigan.

Research Highlights

Phthalate activation of oxidative stress in placental tissues

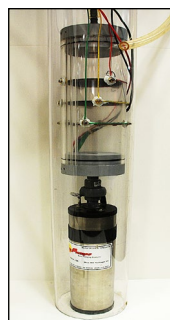
Looking at human placental cells, PROTECT researchers discovered that exposure to di-2-ethylhexyl phthalate (DEHP), a type of phthalate used as a softener in some plastics, triggered an oxidative stress response that may be linked to preterm birth.¹ Oxidative stress is a process in cells that can result in cell and tissue damage and other problems. Rita Loch-Carusio, Ph.D., at the University of Michigan, and her PROTECT team are identifying possible biological explanations to understand how exposure to environmental pollutants, such as phthalates, can lead to early labor and preterm birth.¹



Iman Hassan, Ph.D., analyzes human placental cells exposed to phthalates. (Photo courtesy of Northeastern University)

Using solar power to clean up contaminants

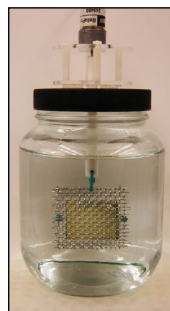
Akram Alshawabkeh, Ph.D., at Northeastern University, leads a PROTECT team that is developing a sustainable, solar-powered system for removing trichloroethylene (TCE) and other contaminants from groundwater.^{2,3} TCE, an industrial solvent and degreaser, is one of the most common soil and groundwater contaminants in the U.S., and is linked to cancer.⁴ The solar panels produce electric currents that trigger chemical reactions in groundwater, changing TCE into a less toxic form.³ The researchers have applied for a patent on this device, and are currently testing whether it can be used to clean up other contaminants.



A pilot-scale setup of a solar-powered reactor for on-site transformation of contaminants in groundwater is currently being tested. (Photo courtesy of Northeastern University)

Developing detection and exposure assessment tools

Roger Giese, Ph.D., at Northeastern University, and his PROTECT team invented a convenient tool, the Porous Extraction Paddle (PEP), to extract contaminants from a large volume of urine or water at a remote location for later testing in the lab.⁵ The PEP device will greatly reduce researcher efforts and costs by simplifying field collection of samples, which can number in the thousands.



The PEP device, which resembles a tea bag, extracts chemicals from urine or water in the field so the samples are conveniently-sized for shipment to a lab for analysis. (Photo courtesy of Northeastern University)

Northeastern University



The Northeastern University PROTECT SRC is studying exposure to environmental contaminants and their contribution to preterm birth, or births occurring before 37 weeks of gestation, in the United States, and U.S. territory of Puerto Rico. They also seek to better understand movement of hazardous chemicals in groundwater systems, and develop green cleanup strategies to reduce exposures.

Center Contact:

Akram Alshawabkeh, Ph.D.

Northeastern University

Department of Civil and Environment Engineering

aalsha@neu.edu

617-373-3994

Transport and exposure pathways in groundwater systems

Ingrid Padilla, Ph.D., and her team at the University of Puerto Rico at Mayaguez identified flow patterns of contaminants in a specific type of groundwater system, called karst aquifers, that supply drinking water in Puerto Rico, as well as several U.S. states and much of the developing world.^{6,7} The karst aquifers contain cave systems that are vulnerable to contamination from toxic chemicals, such as DEHP and TCE, which are believed to contribute to Puerto Rico's high preterm birth rate.⁸ So far, their data supports the hypothesis that the aquifers have a large capacity to store and slowly release contaminants.⁹



Hydrogeologist Padilla, left, and students examine well equipment installed through the Monte Encantado aquifer cave in Puerto Rico. (Photo courtesy of Northeastern University)

The importance of studying Superfund contaminants

- In Puerto Rico, the preterm birth rate is nearly 20 percent of live births,⁸ and evidence suggests that exposures to Superfund and related contaminants are contributing factors.
- The racial, ethnic, and socioeconomic status of the community, along with the high risk of exposure to contaminants, highlight the relevance of PROTECT to environmental justice.

Research overview

- **Identifying chemicals that contribute to preterm birth.**
(Roger Giese, Ph.D., Northeastern University, r.giese@neu.edu)
- **Understanding how contaminants move into and through aquifers, and the impact on exposure risks.**
(Ingrid Padilla, Ph.D., University of Puerto Rico at Mayaguez, ingrid.padilla@upr.edu)
- **Applying state-of-the-art methods to study biological mechanisms involved in preterm birth related to environmental factors.**
(John Meeker, Sc.D., University of Michigan, meekerj@umich.edu)
- **Creating solar-powered systems to clean up Superfund chemicals from aquifers.**
(Akram Alshawabkeh, Ph.D., Northeastern University, aalsha@neu.edu)
- **Studying biological pathways that link exposures to contaminants to preterm birth.**
(Rita Loch-Caruso, Ph.D., University of Michigan, rlc@umich.edu)

Sharing results

- PROTECT serves as a bridge between researchers, communities, government agencies, and stakeholders to foster effective communication and application of research findings and technologies. (Phil Brown, Ph.D., Northeastern University, p.brown@neu.edu)

Other contributions to advance science

- The PROTECT SRC research support facility provides vital access to expertise, research resources, and state-of-the-art instrumentation for its research projects.
(Jose Cordero, M.D., University of Puerto Rico, jose.cordero6@upr.edu;
David Kaeli, Ph.D., Northeastern University, kaeli@ece.neu.edu)
- The PROTECT SRC integrated, multidisciplinary training experience provides early-career scientists access to teams of diverse professionals, and encourages innovation to develop solution-oriented approaches to complex environmental health problems.
(Thomas Sheahan, Ph.D., Northeastern University, t.sheahan@neu.edu)

NIEHS Grant Number:

P42ES017198

Grant Period: 2010-2019

NIEHS Contacts:

William Suk, Ph.D.

Director
Superfund Research Program
suk@niehs.nih.gov
919-541-0797

Heather Henry, Ph.D.

Program Administrator
Superfund Research Program
henryh@niehs.nih.gov
919-541-5330

Legislative Authority:

Section 311(a) of the Superfund Amendments and Reauthorization Act (SARA) of 1986

For more information on the National Institute of Environmental Health Sciences, visit www.niehs.nih.gov.

For more information on the Superfund Research Program, visit www.niehs.nih.gov/srp.

For more information on the Northeastern University Superfund Research Center, visit www.northeastern.edu/protect.

¹ Tetz, LM, Cheng AA, Korte CS, Giese RW, Wang P, Harris C, Meeker JD, Loch-Caruso R. 2013. Mono-2-ethylhexyl phthalate induces oxidative stress responses in human placental cells in vitro. *Toxicol Appl Pharmacol* 268(1):47-54.

² Yuan S, Liao P, Alshawabkeh AN. 2014. Electrolytic manipulation of persulfate reactivity by iron electrodes for trichloroethylene degradation in groundwater. *Environ Sci Technol* 48(1):656-663.

³ PROTECT (Puerto Rico Testsite for Exploring Contamination Threats). 2014. Project 5: Green Remediation by Solar Energy Conversion Into Electrolysis in Groundwater. Available: www.northeastern.edu/protect/research/p5 [accessed 1 June 2015].

⁴ ATSDR (Agency for Toxic Substances and Disease Registry). 2014. ToxFaq's for Trichloroethylene (TCE). Available: www.atsdr.cdc.gov/toxfaqs/tf.asp?id=172&tid=30 [accessed 1 June 2015].

⁵ PROTECT (Puerto Rico Testsite for Exploring Contamination Threats). Project 3: Discovery of Xenobiotics Associated with Preterm Birth. Available: www.northeastern.edu/protect/research/p3 [accessed 1 June 2015].

⁶ Anaya AA, Padilla I, Macchiavelli R, Vesper D, Meeker JD, Alshawabkeh AN. 2014. Estimating preferential flow in karstic aquifers using statistical mixed models. *Groundwater* 52(4):584-596.

⁷ USGS (U.S. Geological Survey). 2012. Karst and the USGS. Available: <http://water.usgs.gov/ogw/karst/index> [accessed 1 June 2015].

⁸ Martin JA, Hamilton BE, Ventura SJ, Osteman MJK, Wilson EC, Mathews TJ. 2012. Births: Final Data for 2010. *Natl Vital Stat Rep* 61(1):1-72.

⁹ Padilla I, Irizarry C, Steele K. 2011. Historical contamination of groundwater resources in the North Coast Karst Aquifers of Puerto Rico. *Rev Dimens* 3:7-12.